L. ERIE

Water management in Ontario

Ontario
Water Resources
Commission

Great Lakes
Water Quality
Surveys Program



# WATER CHEMISTRY

# NANTICOKE AREA

# LAKE ERIE

# 1969

Water Quality Surveys
Ontario Water Resources Commission
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# WATER CHEMISTRY

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## ABSTRACT

Monthly evaluation of the water chemistry characteristics at eight buoy marked in the Nanticoke area of Lake Erie for the period April to December 1969 are presented. The survey area extends 2.4 km offshore and 8.8 km along the shore. The bottom is hard clay and water depths do not exceed 12 m. It was found that the area is generally homogeneous in water chemistry with little or no stratification with depth during the survey period.

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## WATER CHEMISTRY

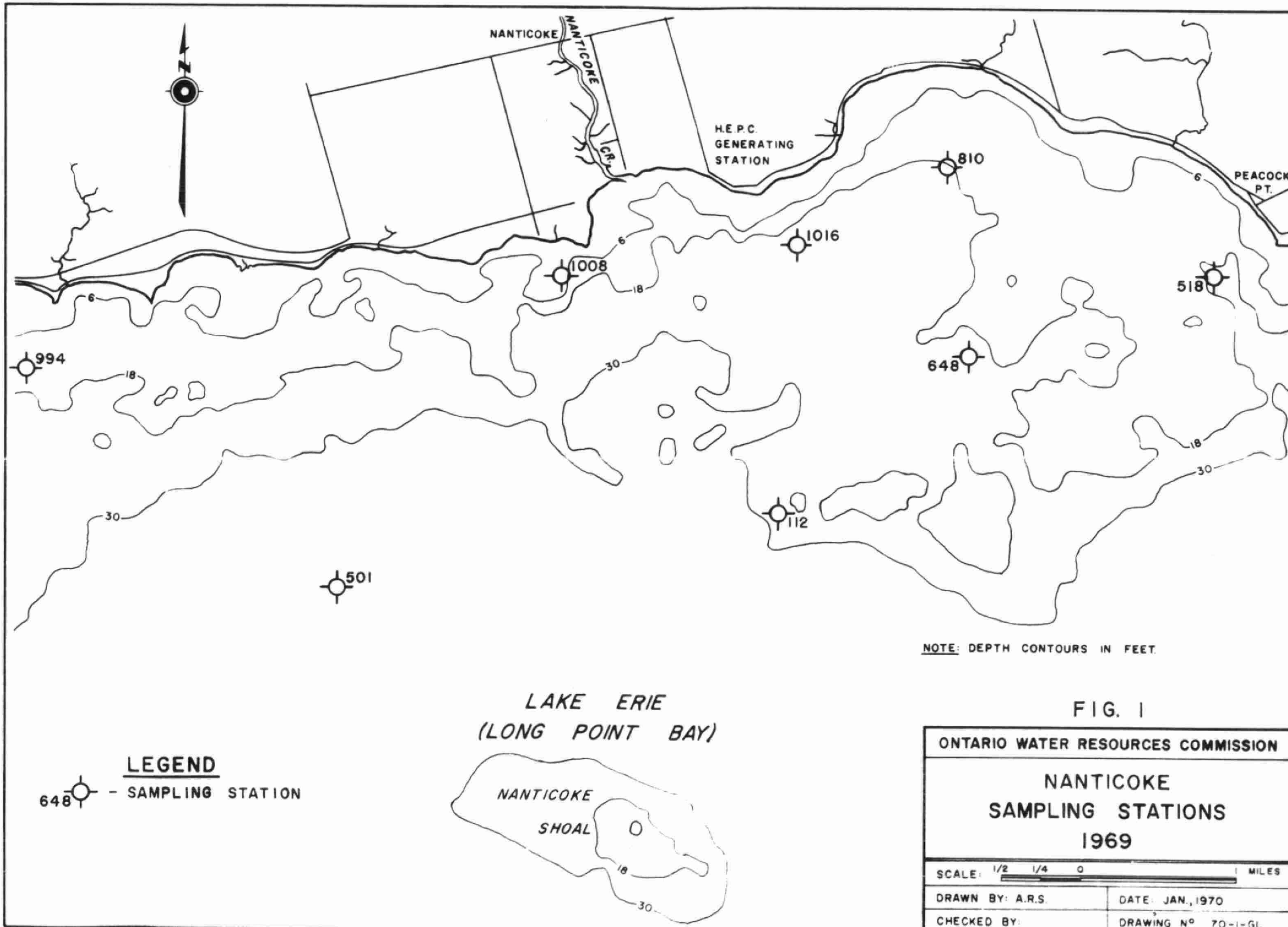
## NANTICOKE AREA

## LAKE ERIE

## 1969

### INTRODUCTION

A study of the existing water chemistry, biological and physical characteristics of the aquatic environment in the Nanticoke area was initiated in 1968. This is a co-operative study carried out by the Steel Company of Canada (Stelco), the Hydro-Electric Power Commission of Ontario (HEPCO), the Department of Lands and Forests (L & F), and the Ontario Water Resources Commission (OWRC). It was agreed that most of the study activity would be concentrated at eight designated stations in the area which were selected on the basis of statistical analysis of 24-hour water chemistry surveys on a dense sampling grid carried out in 1968 (Required Density of Water Quality Sampling Stations at Nanticoke, Lake Erie 1968, OWRC Report). By concentrating the study activities of all agencies on the eight stations, the data collected could easily be interrelated. HEPCO assumed the responsibility of gathering chemical water samples at these locations. The analyses of the samples was carried out by the Department of Lands and Forests and OWRC.


N
NANTICOKE
NANTICOKE
CR.
H.E.P.C.
GENERATING
STATION
PEACOCK
PT.
810
1016
1008
518
994
648
112
501
6
18
30
NOTE: DEPTH CONTOURS IN FEET.
LAKE ERIE
(LONG POINT BAY)
NANTICOKE
SHOAL
LEGEND
648 - SAMPLING STATION
FIG. 1
ONTARIO WATER RESOURCES COMMISSION
NANTICOKE
SAMPLING STATIONS
1969
SCALE: 1/2 1/4 0 1 MILES
DRAWN BY: A.R.S.
DATE: JAN., 1970
CHECKED BY:
DRAWING No 70-1-GL

This report summarizes the chemical analysis of the samples taken on the Nanticoke station sampling grid (see Figure 1). A listing of the chemical results by sampling time and location appears in Appendix 2. The respective summary is contained in Appendix 1. The results were assessed by employing statistical methods to validate the selection of the station density determined in 1968.

## ANALYSIS OF RESULTS

The dissolved oxygen, pH, and temperature were determined at the time of sampling, and all other chemical parameters for the collected grab samples were measured employing standard methods (American Public Health Association, 1965) in a laboratory. The values of the 1969 results for the respective stations noted in Tables, Appendix 2, were subjected to various statistical tests.

Analysis of variance (both parametric and non-parametric) was carried out on the survey data to determine whether differences occurred between stations and between dates for the chemical characteristics measured. Testing of results was restricted to samples collected at the same depth for one-way tests. The appropriate degrees of freedom for the various tests were obtained from Appendix 2. All block plans for the analysis of variance were complete and no data was generated to fill missing elements in the blocks. The analysis of variance was carried out by dropping stations with an incomplete number of readings. No effort was made to carry out pair-testing either by time or by

location. The results of the parametric two-way analysis of variance appears in Table 1. It is observed that a significant difference between the stations were restricted to alkalinity and turbidity, while a significant time variance was present for pH and alkalinity. The non-parametric one-way analysis of variance test (Kruskal-Wallis) in Table 2 demonstrated that the only significant difference is between the stations in turbidity and weakly in alkalinity. Statistical analysis of group sample results in 1968 indicated that it was advisable to use non-parametric analysis (Palmer, 1968). The 1969 results indicate that the station selection for monitoring was reasonable and should be maintained in 1970. No significant difference with depth was found for any of the parameters tested. It would appear that there is little value in taking both shallow and deep samples at the stations. The same information can be collected from one mid-depth sample.

This study is intended to provide baseline information on the water environment in the Nanticoke area before the operation of the industrial complex commences. The summary in Appendix 1 provides the information concerning the seasonal and between station variations as detected in the 1969 survey. Seasonal trends from Appendix 1 are plotted in Figures 2A and 2B. It should be noted in examining these tables that many of the concentrations appearing in the tables are at the limit of the sensitivity range for the evaluation techniques (American Public Health Association, 1965 and Palmer, 1968). In

TABLE 1

PARAMETRIC TWO-WAY ANALYSIS OF VARIANCE

| Parameter | Source of Variance | F Test | F | Significant Difference |
|---|---|---|---|---|
| Alkalinity | Stations | $\frac{339.8}{7.1}$ = 47.8 | F0.05; 3; 3 = 9.28 | SD* |
| | Depths | $\frac{25.8}{7.1}$ = 3.6 | F0.05; 1; 3 = 10.1 | NSD |
| | Time | $\frac{356.8}{153}$ = 2.3 | F0.05; 6; 24 = 2.51 | NSD |
| | Station & Time | $\frac{83.4}{153}$ = .54 | F0.04; 18; 24 = 2.05 | NSD |
| pH | Stations | $\frac{.2}{.6}$ = .33 | F0.05; 2; 2 = 19.0 | NSD |
| | Depths | $\frac{.7}{.6}$ = 1.17 | F0.05; 1; 2 = 18.5 | NSD |

* SD - significantly different
NSD - not significantly different

TABLE 1 (cont'd)

| Parameter | Source of Variance | F Test | F | Significant Difference |
|---|---|---|---|---|
| | Time | $\frac{10.6}{1.48}$ = 7.1 | F0.05; 6; 18 = 2.66 | SD |
| | Station & Time | $\frac{1.8}{1.48}$ = 1.21 | F0.05; 12; 18 = 2.34 | NSD |
| Turbidity | Station | $\frac{4.3}{7.0}$ = .6 | F0.05; 2; 2 = 19.0 | NSD |
| | Depths | $\frac{15.2}{7.0}$ = 2.2 | F0.05; 1; 2 = 18.5 | NSD |
| | Time | $\frac{7.7}{6.3}$ = 1.2 | F0.05; 5; 15 = 2.90 | NSD |
| | Station & Time | $\frac{1.4}{6.3}$ = .22 | F0.05; 10; 15 = 2.54 | NSD |

TABLE 2A

NON-PARAMETRIC

KRUSKAL-WALLIS

ONE-WAY ANALYSIS OF VARIANCE

DEEP SAMPLES BETWEEN STATIONS

| Parameter | Test Statistic (Adjusted) | Degrees of Freedom | Probability |
|---|---|---|---|
| pH | .430 | 5 | .99 |
| Alkalinity | 3.8 | 5 | .70 |
| $NH_3$ | 1.01 | 4 | .98 |
| $NO_2$ | 4.02 | 5 | .70 |
| $NO_3$ | .777 | 5 | .98 |
| Dissolved P | | 5 | |
| Kjeldahl | 2.71 | 5 | .80 |
| Turbidity | 4.82 | 5 | .50 |

TABLE 2B

NON-PARAMETRIC

KRUSKAL-WALLIS

ONE-WAY ANALYSIS OF VARIANCE

SHALLOW SAMPLES BETWEEN STATIONS

| Parameter | Test Statistic (Adjusted) | Degrees of Freedom | Probability |
|---|---|---|---|
| pH | 1.38 | 7 | .99 |
| Alkalinity | 7.03 | 7 | .50 |
| $NH_3$ | 4.43 | 7 | .80 |
| $NO_2$ | 1.89 | 7 | .98 |
| $NO_3$ | .91 | 7 | .99 |
| Dissolved P | 2.25 | 7 | .95 |
| Kjeldahl | 4.01 | 7 | .80 |
| Turbidity | 9.76 | 7 | .30 |

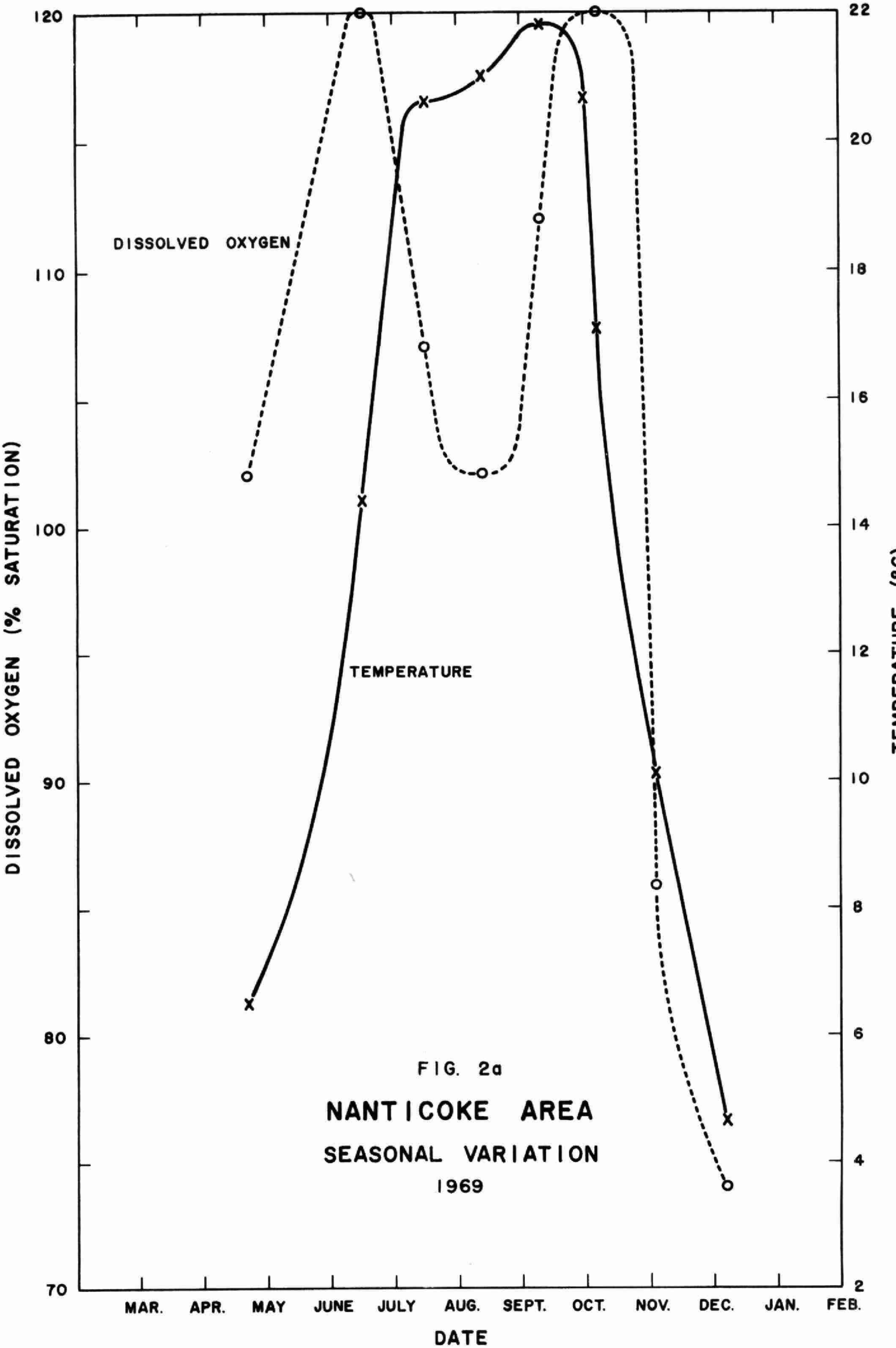



FIG. 2a

**NANTICOKE AREA**

SEASONAL VARIATION

1969

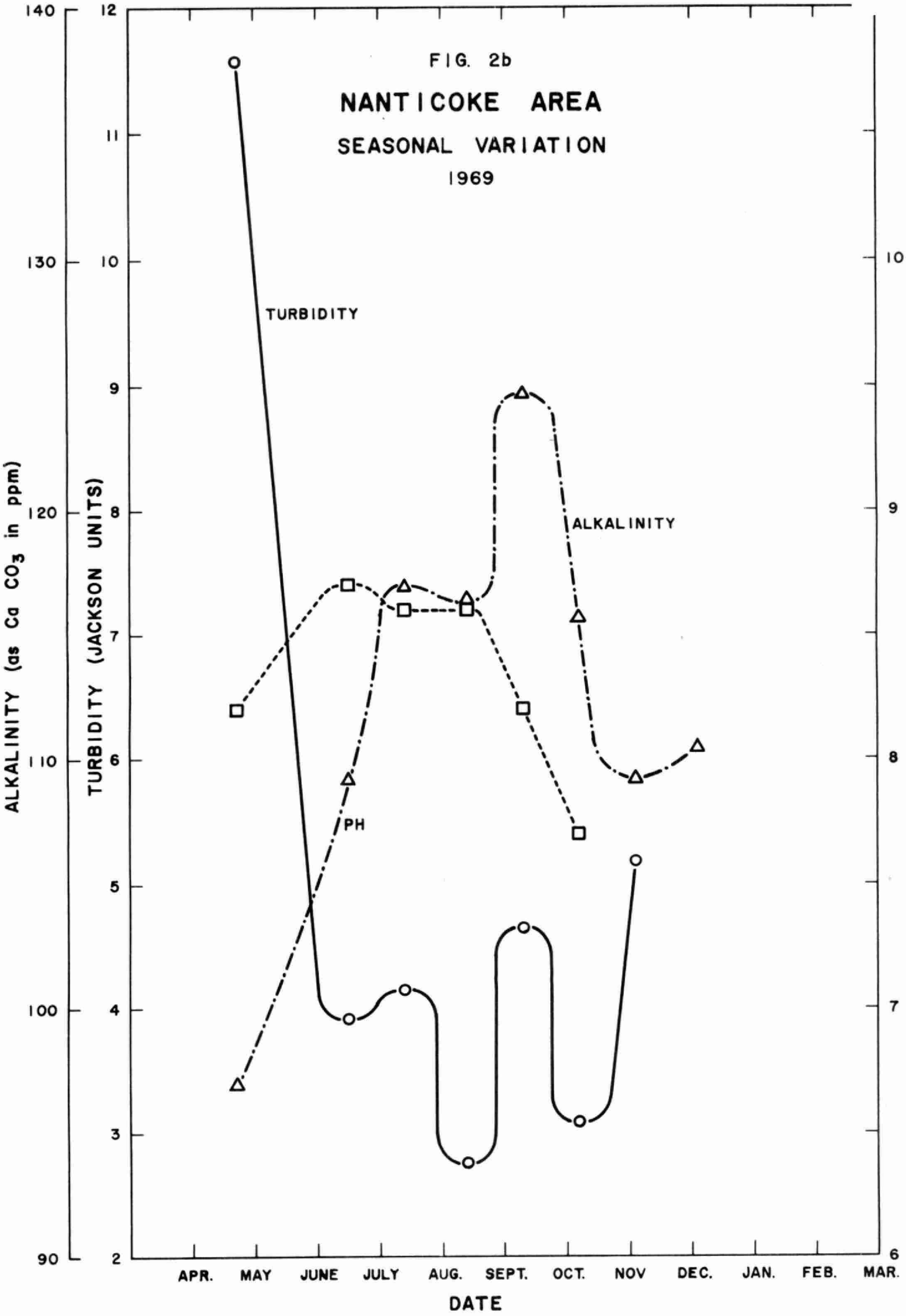


FIG. 2b
NANTICOKE AREA
SEASONAL VARIATION
1969
TURBIDITY
ALKALINITY
PH
ALKALINITY (as Ca $CO_3$ in ppm)
TURBIDITY (JACKSON UNITS)
140
130
120
110
100
90
12
11
10
9
8
7
6
5
4
3
2
10
9
8
7
6
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV
DEC.
JAN.
FEB.
MAR.
DATE

particular, ammonia, $N0_2$, $N0_3$, and soluble phosphorus are below the sensitivity levels of the test and consequently, the variations recorded are doubtful. Similarly, the total phosphorus is in the range of 10 to 30 ppb which is at the lower sensitivity extreme of the total phosphorus test. Consequently, it is subjected to errors.

## CONCLUSIONS

The water quality sampling in 1969 has revealed that the water chemistry in the area represented in Figure 1 is reasonably homogeneous with only small differences occurring between stations in alkalinity and turbidity. There appears to be no significant chemical variations with depth and no appreciable stratification between the months of April and December. There is a significant seasonal variation occurring in the area particularly with respect to pH and alkalinity. The measured chemical parameters of ammonia, $N0_2$, $N0_3$, soluble and total phosphorus are at the lower sensitivity limits of the analytical procedures used in determining the concentrations. Consequently, concentrations of these measured parameters must be interpreted with some discretion.

## RECOMMENDATIONS

It is recommended that the sampling grid be used in 1970 and that the sampling at the stations be reduced to one mid-depth sample.

## REFERENCES

American Public Health Association Inc., 1965. Standard Methods for the Examination of Water and Wastewater.

Palmer, M.D., 1968. Review of Water Quality Station Density Statistical Procedures. Ontario Water Resources Commission.

# TABLE I

# SUMMARY OF RESULTS BY STATION

| Station | Depth (ft.) | | Avg. Cond. umho/cm | | Avg. Temp. °C | | Avg. DO ppm | | Avg. pH (Su) | | Avg. Alk. ppm $CaCO_3$ | | Avg. $NH_3$ ppm N | | Avg. $NO_2$ ppm N | | Avg. $NO_3$ ppm N | | Avg. Diss. P. ppm P | | Avg. Phenols ppb | | Avg. Kjel. ppm N | | Avg. Tot. P. ppm P | | Avg. Turbidity Jackson Unit | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | 325 | 324 | 15.1 | 14.9 | 9.6 | 8.2 | 8.1 | 8.2 | 111 | 115 | .04 | .06 | .005 | .006 | .06 | .06 | .01 | .01 | 0 | 2 | .25 | .31 | .02 | .02 | 4.0 | 3.6 |
| 501 | 1.0 | 9.0 | 325 | 327. | 15.2 | 14.3 | 10.3 | 8.6 | 8.4 | 8.3 | 114 | 118 | .04 | .04 | .005 | .007 | .06 | .07 | .01 | .01 | 0 | 0 | .25 | .29 | .02 | .02 | 3.3 | 5.9 |
| 518 | 3.0 | | 327 | | 13.7 | | 8.9 | | 8.4 | | 109 | | .05 | | .006 | | .09 | | .01 | | 0 | | .27 | | .02 | | 7.3 | |
| 648 | 1.0 | 7.0 | 324 | 324 | 13.1 | 13.7 | 10.5 | 10.7 | 8.2 | 8.0 | 114 | 112 | .04 | .05 | .005 | .004 | .07 | .06 | .01 | .01 | 0 | 0 | .30 | .27 | .02 | .02 | 4.2 | 3.8 |
| 810 | 1.0 | 8.0 | 324 | 323 | 13.9 | 14.2 | 9.9 | 9.0 | 8.5 | 8.5 | 104 | 108 | .06 | .05 | .006 | .006 | .07 | .06 | .01 | .01 | 0 | 0 | .28 | .26 | .02 | .02 | 5.2 | 4.2 |
| 994 | 1.0 | 7.0 | 327 | 327 | 14.3 | 14.6 | 10.7 | 10.0 | 8.3 | 8.3 | 114 | 116 | .05 | .05 | .006 | .006 | .07 | .02 | .01 | .01 | 0 | 0 | .29 | .28 | .03 | .02 | 5.3 | 5.2 |
| 1008 | 3.0 | | 329 | 330 | 14.2 | | 11.4 | | 8.3 | | 117 | | .05 | | .006 | | .07 | | .01 | | 0 | | .34 | | .02 | | 6.7 | |
| 1016 | 1.0 | 9.0 | 325 | 321 | 14.1 | 14.1 | 9.6 | 8.8 | 8.2 | 8.1 | 114 | 110 | .04 | .05 | .005 | .005 | .07 | .06 | .01 | .01 | 0 | 0 | .29 | .24 | .02 | .02 | 6.0 | 4.0 |

# TABLE 2

# SUMMARY OF RESULTS BY DATE

| DATE | Avg. Cond. umho/cm | | Avg. Temp. °C | | Avg. DO ppm | | Avg. pH (Su) | | Avg. Alk. ppm $CaCO_3$ | | Avg. $NH_3$ ppm N | | Avg. $NO_2$ ppm N | | Avg. $NO_3$ ppm N | | Avg. Diss. P. ppm P | | Avg. Phen. ppb | | Avg. Kjel. ppm N | | Avg. Tot. P. ppm P | | Avg. Turbidity Jackson Units | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| Apr. 20 | 330 | | 6.5 | | 12.0 | | 8.2 | | 97 | | .05 | | .006 | | .18 | | .00 | | 0 | | .37 | | .03 | | 11.6 | |
| June 16 | 327 | 328 | 14.4 | 11.4 | 12.0 | 11.6 | 8.7 | 8.5 | 109 | 112 | .06 | .08 | .005 | .005 | .05 | .07 | .01 | .01 | 0 | 0 | .18 | .20 | .01 | .02 | 3.9 | 5.1 |
| July 14 | 331.1 | 332 | 20.6 | 17.7 | 9.3 | 7.6 | 8.6 | 8.5 | 117 | 110 | .07 | .08 | .005 | .006 | .04 | .06 | .01 | .01 | 0 | 0 | .35 | .36 | .02 | .03 | 4.1 | 5.9 |
| Aug. 12 | 328.1 | 329 | 21.0 | 20.0 | 8.9 | 7.4 | 8.6 | 8.5 | 116 | 114 | .05 | .05 | .010 | .010 | .03 | .05 | .01 | .01 | 0 | 0 | .25 | .28 | .01 | .01 | 2.7 | 2.8 |
| Sept. 8 | 320 | 316 | 21.8 | 21.4 | 9.5 | 8.5 | 8.2 | 8.1 | 125 | 125 | .04 | .04 | .004 | .005 | .02 | .03 | .01 | .01 | 0 | 2 | .26 | .28 | .01 | .02 | 4.6 | 4.3 |
| Oct. 6 | 321 | 321 | 17.1 | 17.0 | 11.4 | 8.4 | 7.7 | 7.6 | 116 | 114 | .01 | .01 | .004 | .004 | .02 | .02 | .01 | .01 | 0 | 0 | .33 | .26 | .02 | .02 | 3.1 | 2.9 |
| Nov. 3 | 323 | 324 | 10.1 | 9.9 | 9.3 | 9.6 | 7.9 | 7.9 | 109 | 111 | .02 | .03 | .004 | .003 | .13 | .13 | .01 | .01 | 0 | 0 | | | .03 | .02 | 5.2 | 4.9 |
| Dec. 4 | | | 4.7 | 5.2 | 9.1 | 10.8 | | | 111 | 109 | | | | | | | | | | | | | | | | |

TABLE 1

TEMPERATURE

°C

| 1969 | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | 5.5 | | 15.0 | 11.0 | 22.0 | 17.5 | 21.0 | 20.0 | 23.2 | 22.7 | 17.5 | 17.0 | 9.8 | 10.0 | 6.4 | 6.4 | 15.1 | 14.9 |
| 501 | 1.0 | 9.0 | 6.5 | | 15.5 | 10.0 | 21.0 | 17.5 | 21.0 | 19.5 | 22.9 | 20.4 | 17.0 | 17.0 | 10.8 | 10.3 | 5.5 | 5.4 | 15.2 | 14.3 |
| 518 | 3.0 | | 7.0 | | 13.5 | | 19.0 | | 22.0 | | 21.0 | | | | 10.0 | | 3.4 | | 13.7 | |
| 648 | 1.0 | 7.0 | 6.8 | | 14.5 | 13.5 | 21.0 | 18.5 | | | 20.9 | 20.9 | | | 9.6 | 9.5 | 6.1 | 6.0 | 13.1 | 13.7 |
| 810 | 1.0 | 8.0 | 7.0 | | 13.5 | 11.0 | 19.5 | 18.0 | 22.0 | 21.0 | 21.0 | 21.2 | | | 10.0 | 10.0 | 4.2 | 4.0 | 13.9 | 14.2 |
| 994 | 1.0 | 7.0 | 6.6 | | 14.5 | 12.0 | 21.0 | 17.5 | 19.0 | 18.5 | 22.2 | 22.4 | 17.0 | 17.0 | 10.0 | 10.0 | 4.5 | 4.7 | 14.3 | 14.6 |
| 1008 | 3.0 | | 6.0 | | 15.0 | | 20.0 | | 20.0 | | 21.9 | | 17.0 | | 10.5 | | 3.5 | | 14.2 | |
| 1016 | 1.0 | 9.0 | 6.8 | | 13.5 | 11.0 | 21.0 | 17.6 | 22.0 | 21.0 | 21.4 | 20.7 | | | 9.8 | 9.7 | 4.4 | 4.8 | 14.1 | 14.1 |
| Mean | | | 6.5 | | 14.4 | 11.4 | 20.6 | 17.7 | 21.0 | 20.0 | 21.8 | 21.4 | 17.1 | 17.0 | 10.1 | 9.9 | 4.7 | 5.2 | | |

TABLE 2

DISSOLVED OXYGEN

ppm

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | 12.6 | | 11.6 | 12.8 | 6.0 | 5.7 | 9.8 | 6.0 | 9.1 | 7.3 | 10.2 | 7.5 | 6.5 | 8.7 | 10.7 | 9.4 | 9.6 | 8.2 |
| 501 | 1.0 | 9.0 | 12.4 | | 12.3 | 11.3 | 9.4 | 8.3 | 7.3 | 7.9 | 8.8 | 7.4 | 15.0 | 9.7 | 9.8 | | 7.0 | 8.2 | 10.3 | 8.6 |
| 518 | 3.0 | | 11.6 | | 8.9 | | 7.2 | | 6.7 | | 9.0 | | | | 7.9 | | 10.6 | | 8.9 | |
| 648 | 1.0 | 7.0 | 12.4 | | 11.2 | 10.4 | 9.7 | 9.0 | | | 9.4 | 8.8 | | | 8.7 | 13.4 | 11.5 | 12.1 | 10.5 | 10.8 |
| 810 | 1.0 | 8.0 | 11.0 | | 10.0 | 8.0 | 8.6 | 6.7 | 12.0 | 7.9 | 8.4 | 8.9 | | | 7.0 | 6.9 | 11.5 | 15.4 | 9.9 | 9.0 |
| 994 | 1.0 | 7.0 | 11.8 | | 13.7 | 15.9 | 12.9 | 7.8 | 8.6 | 7.3 | 13.0 | 10.9 | 10.1 | 8.0 | 8.2 | | 7.5 | 10.9 | 10.7 | 10.1 |
| 1008 | 3.0 | | 11.6 | | 15.0 | | 11.8 | | 7.5 | | 10.5 | | 10.2 | | 16.6 | | 7.6 | | 11.4 | |
| 1016 | 1.0 | 9.0 | 12.0 | | 13.5 | 11.0 | 8.6 | 7.9 | 10.0 | 8.1 | 7.7 | 7.6 | | | 9.5 | 9.4 | 6.0 | 8.7 | 9.6 | 8.8 |
| Mean | | | 12.0 | | 12.0 | 11.6 | 9.3 | 7.6 | 9.0 | 7.4 | 9.5 | 8.5 | 11.4 | 8.4 | 9.3 | 9.6 | 9.1 | 10.8 | | |

TABLE 3

pH

Su

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | 8.1 | | 8.9 | 8.7 | 8.6 | 8.4 | 8.4 | 8.3 | 8.3 | 8.3 | 7.5 | 7.5 | 7.2 | 7.8 | | | 8.1 | 8.2 |
| 501 | 1.0 | 9.0 | 8.4 | | 8.9 | 8.6 | 8.9 | 8.6 | 8.7 | 8.6 | 8.3 | 7.7 | 7.7 | 7.7 | 8.0 | 8.3 | | | 8.4 | 8.3 |
| 518 | 3.0 | | 8.1 | | 8.6 | | 8.3 | | 8.8 | | 8.1 | | | | 8.3 | | | | 8.4 | |
| 648 | 1.0 | 7.0 | 8.1 | | 8.4 | 8.7 | 8.5 | 8.4 | | | 8.0 | 8.0 | | | 7.8 | 7.0 | | | 8.2 | 8.0 |
| 810 | 1.0 | 8.0 | 8.1 | | 8.7 | 8.7 | 8.7 | 8.9 | 8.6 | 8.7 | 8.7 | 8.1 | | | 8.3 | 8.2 | | | 8.5 | 8.5 |
| 994 | 1.0 | 7.0 | 8.3 | | 8.7 | 8.6 | 8.8 | 8.4 | 8.6 | 8.4 | 8.2 | 8.2 | 7.7 | 7.7 | 8.1 | 8.5 | | | 8.3 | 8.3 |
| 1008 | 3.0 | | 8.1 | | 8.6 | | 8.6 | | | | 8.1 | | 8.1 | | 8.0 | | | | 8.3 | |
| 1016 | 1.0 | 9.0 | 8.2 | | 8.6 | 8.0 | 8.6 | 8.6 | 8.5 | 8.6 | 7.7 | 7.6 | | | 7.7 | 7.9 | | | 8.2 | 8.1 |
| Mean | | | 8.2 | | 8.7 | 8.5 | 8.6 | 8.5 | 8.6 | 8.5 | 8.2 | 8.1 | 7.7 | 7.6 | 7.9 | 7.9 | | | | |

TABLE 4

ALKALINITY

as $CaCO_3$ ppm

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 122 | 1.0 | 12.0 | 96 | | 82 | 120 | 132 | 115 | 122 | 115 | 132 | 128 | 107 | 106 | 113 | 111 | 106 | 107 | 111 | 115 |
| 501 | 1.0 | 9.0 | 98 | | 122 | 125 | 114 | 110 | 114 | 121 | 134 | 129 | 106 | 127 | 116 | 112 | 106 | 105 | 114 | 118 |
| 518 | 3.0 | | 96 | | 108 | | 112 | | 120 | | 115 | | 109 | | 95 | | 114 | | 109 | |
| 648 | 1.0 | 7.0 | 96 | | 111 | 114 | 117 | 112 | | | 119 | 120 | | | 112 | 106 | 131 | 107 | 114 | 112 |
| 810 | 1.0 | 8.0 | 97 | | 110 | 108 | 105 | 85 | 108 | 105 | 113 | 125 | 104 | 107 | 89 | 112 | 107 | 111 | 104 | 108 |
| 994 | 1.0 | 7.0 | 98 | | 111 | 114 | 125 | 125 | 114 | 115 | 126 | 132 | 125 | 110 | 112 | 108 | 103 | 108 | 114 | 116 |
| 1008 | 3.0 | | 98 | | 111 | | 119 | | 118 | | 134 | | 125 | | 124 | | 105 | | 117 | |
| 1016 | 1.0 | 9.0 | 97 | | 119 | 90 | 111 | 110 | 118 | 112 | 124 | 113 | | | 114 | 116 | 113 | 116 | 114 | 110 |
| Mean | | | 97 | | 109 | 112 | 117 | 110 | 116 | 114 | 125 | 125 | 116 | 114 | 109 | 111 | 111 | 109 | | |

TABLE 5

CONDUCTIVITY

umhos/cm

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | 329 | | 329 | 324 | 330 | 335 | 327 | 328 | 315 | 315 | 322 | 319 | 326 | 324 | | | 325 | 324 |
| 501 | 1.0 | 9.0 | 329 | | 326 | 330 | 330 | 330 | 327 | 330 | 315 | 324 | 322 | 321 | 324 | 324 | | | 325 | 327 |
| 518 | 3.0 | | 332 | | 329 | | 330 | | 327 | | 315 | | | | 326 | | | | 327 | |
| 648 | 1.0 | 7.0 | 327 | | 324 | 327 | 333 | 330 | | | 313 | 313 | | | 324 | 324 | | | 324 | 324 |
| 810 | 1.0 | 8.0 | 327 | | 329 | 329 | 330 | 330 | 327 | 328 | 307 | 306 | | | 322 | 324 | | | 324 | 323 |
| 994 | 1.0 | 7.0 | 337 | | 329 | 329 | 330 | 333 | 327 | 330 | 316 | 321 | | | 323 | 324 | | | 327 | 327 |
| 1008 | 3.0 | | 332 | | 332 | | 333 | 336 | 332 | 333 | 356 | | 322 | 322 | 311 | | | | 329 | 330 |
| 1016 | 1.0 | 9.0 | 327 | | 327 | 326 | 333 | | 330 | 313 | 320 | | 317 | | 324 | 324 | | | 325 | 321 |
| Mean | | | 330 | | 327 | 328 | 331 | 332 | 328 | 327 | 320 | 316 | 321 | 321 | 323 | 324 | | | | |

TABLE 6

TURBIDITY

JACKSON UNITS

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | 7.0 | | 4.3 | 3.4 | 3.4 | 7.2 | 2.2 | 3.1 | 6.0 | 2.0 | 2.2 | 2.2 | 3.1 | 3.6 | | | 4.0 | 3.6 |
| 501 | 1.0 | 9.0 | 5.5 | | 3.1 | 8.3 | 3.4 | 7.0 | 2.7 | 2.0 | 2.0 | 10.0 | 2.2 | 3.4 | 3.9 | 4.6 | | | 3.3 | 5.9 |
| 518 | 3.0 | | 19.0 | | 3.9 | | 5.1 | | 2.0 | | 4.0 | | | | 9.5 | | | | 7.3 | |
| 648 | 1.0 | 7.0 | 8.0 | | 3.4 | 3.9 | 3.4 | 3.6 | | | 3.0 | 3.0 | | | 3.4 | 4.6 | | | 4.2 | 3.8 |
| 810 | 1.0 | 8.0 | 11.0 | | 3.9 | 4.3 | 3.9 | 4.6 | 2.2 | 2.2 | 4.0 | 4.0 | | | 6.4 | 5.9 | | | 5.2 | 4.2 |
| 994 | 1.0 | 7.0 | 11.0 | | 4.1 | 4.8 | 4.6 | 8.6 | 3.4 | 4.3 | 4.0 | 4.0 | 3.6 | 3.1 | 6.1 | 6.1 | | | 5.3 | 5.2 |
| 1008 | 3.0 | | 20.0 | | 4.6 | | 4.6 | | 3.6 | | 4.0 | | 4.3 | | 5.6 | | | | 6.7 | |
| 1016 | 1.0 | 9.0 | 11.0 | | 3.9 | 5.9 | 4.6 | 4.6 | 2.9 | 2.5 | 10.0 | 3.0 | | | 3.4 | 4.6 | | | 6.0 | 4.0 |
| Mean | | | 11.6 | | 3.9 | 5.1 | 4.1 | 5.9 | 2.7 | 2.8 | 4.6 | 4.3 | 3.1 | 2.9 | 5.2 | 4.9 | | | | |

TABLE 7

FREE AMMONIA

AS N ppm

| | 1969 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | .04 | | .04 | .07 | .07 | .12 | .06 | .05 | .03 | .04 | .01 | .01 | .02 | .04 | | | .04 | .06 |
| 501 | 1.0 | 9.0 | .04 | | .05 | .09 | .04 | .02 | .04 | .05 | .03 | .03 | .01 | .01 | .04 | .03 | | | .04 | .04 |
| 518 | 3.0 | | .06 | | .05 | | .07 | | .04 | | .03 | | | | .02 | | | | .05 | |
| 648 | 1.0 | 7.0 | .04 | | .04 | .08 | .07 | .07 | | | .03 | .03 | | | .02 | .02 | | | .04 | .05 |
| 810 | 1.0 | 8.0 | .05 | | .10 | .07 | .08 | .08 | .04 | .04 | .04 | .04 | | | .02 | .02 | | | .06 | .05 |
| 994 | 1.0 | 7.0 | .05 | | .08 | .08 | .09 | .12 | .07 | .05 | .06 | .03 | .01 | .01 | .02 | .03 | | | .05 | .05 |
| 1008 | 3.0 | | .07 | | .05 | | .08 | | .06 | | .03 | | .01 | | .02 | | | | .05 | |
| 1016 | 1.0 | 9.0 | .04 | | .05 | .06 | .07 | .07 | .05 | .05 | .04 | .04 | | | .01 | .01 | | | .04 | .05 |
| Mean | | | .05 | | .06 | .08 | .07 | .08 | .05 | .05 | .04 | .04 | .01 | .01 | .02 | .03 | | | | |

TABLE 8

NITRITE

AS N ppm

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | .005 | | .005 | .005 | .005 | .007 | .011 | .012 | .004 | .004 | .004 | .004 | .004 | .004 | | | .005 | .006 |
| 501 | 1.0 | 9.0 | .004 | | .005 | .005 | .004 | .007 | .011 | .010 | .003 | .013 | .004 | .004 | .004 | .004 | | | .005 | .007 |
| 518 | 3.0 | | .009 | | .005 | | .004 | | .011 | | .004 | | | | .004 | | | | .006 | |
| 648 | 1.0 | 7.0 | .006 | | .005 | .005 | .005 | .004 | | | .004 | .004 | | | .003 | .003 | | | .005 | .004 |
| 810 | 1.0 | 8.0 | .007 | | .005 | .005 | .006 | .006 | .010 | .010 | .004 | .004 | | | .003 | .003 | | | .006 | .006 |
| 994 | 1.0 | 7.0 | .006 | | .005 | .004 | .005 | .007 | .010 | .011 | .004 | .003 | .004 | .004 | .004 | .004 | | | .006 | .006 |
| 1008 | 3.0 | | .008 | | .006 | | .005 | | .010 | | .004 | | .004 | | .003 | | | | .006 | |
| 1016 | 1.0 | 9.0 | .006 | | .005 | .005 | .005 | .004 | .009 | .008 | .004 | .004 | | | .003 | .002 | | | .005 | .005 |
| Mean | | | .006 | | .005 | .005 | .005 | .006 | .010 | .010 | .004 | .005 | .004 | .004 | .004 | .003 | | | | |

TABLE 9

NITRATE

AS N ppm

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | .14 | | .04 | .08 | .03 | .07 | .01 | .03 | .02 | .02 | .02 | .02 | .14 | .14 | | | .06 | .06 |
| 501 | 1.0 | 9.0 | .11 | | .04 | .09 | .05 | .06 | .03 | .05 | .01 | .08 | .02 | .02 | .13 | .13 | | | .06 | .07 |
| 518 | 3.0 | | .28 | | .06 | | .05 | | .02 | | .01 | | | | .13 | | | | .09 | |
| 648 | 1.0 | 7.0 | .16 | | .04 | .04 | .03 | .05 | | | .01 | .01 | | | .13 | .13 | | | .07 | .06 |
| 810 | 1.0 | 8.0 | .19 | | .06 | .07 | .03 | .05 | .01 | .04 | .02 | .02 | | | .13 | .13 | | | .07 | .06 |
| 994 | 1.0 | 7.0 | .20 | | .05 | .07 | .05 | .07 | .07 | .09 | .01 | .01 | .02 | .02 | .12 | .12 | | | .07 | .02 |
| 1008 | 3.0 | | .19 | | .05 | | .05 | | .04 | | .02 | | .02 | | .12 | | | | .07 | |
| 1016 | 1.0 | 9.0 | .15 | | .06 | .07 | .01 | .06 | .03 | .03 | .02 | .02 | | | .12 | .12 | | | .07 | .06 |
| Mean | | | .18 | | .05 | .07 | .04 | .06 | .03 | .05 | .02 | .03 | .02 | .02 | .13 | .13 | | | | |

TABLE 10

DISSOLVED PHOSPHORUS

AS P ppm

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | .00 | | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .03 | .01 | | | .01 | .01 |
| 501 | 1.0 | 9.0 | .00 | | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .02 | .01 | | | .01 | .01 |
| 518 | 3.0 | | .01 | | .01 | | .01 | | .01 | | .01 | | .01 | | .01 | | | | .01 | |
| 648 | 1.0 | 7.0 | .01 | | .01 | .01 | .01 | .01 | | | .01 | .01 | | | .01 | .01 | | | .01 | .01 |
| 810 | 1.0 | 8.0 | .00 | | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | | | .01 | .01 | | | .01 | .01 |
| 994 | 1.0 | 7.0 | .00 | | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | | | .01 | .01 |
| 1008 | 3.0 | | .01 | | .01 | | .01 | | .01 | | .01 | | .01 | | .01 | | | | .01 | |
| 1016 | 1.0 | 9.0 | .00 | | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | | | .01 | .01 | | | .01 | .01 |
| Mean | | | .00 | | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | | | | |

TABLE 11

TOTAL KJELDAHL NITROGEN

AS N ppm

| 1 9 6 9 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | .40 | | .08 | .24 | .25 | .41 | .24 | .33 | .24 | .33 | .31 | .23 | | | | | .25 | .31 |
| 501 | 1.0 | 9.0 | .34 | | .10 | .18 | .31 | .33 | .24 | .32 | .27 | .31 | .26 | .32 | | | | | .25 | .29 |
| 518 | 3.0 | | .37 | | .17 | | .46 | | .17 | | .20 | | | | | | | | .27 | |
| 648 | 1.0 | 7.0 | .31 | | .24 | .18 | .38 | .35 | | | .27 | .28 | | | | | | | .30 | .27 |
| 810 | 1.0 | 8.0 | .39 | | .12 | .16 | .39 | .37 | .22 | .33 | .30 | .19 | | | | | | | .28 | .26 |
| 994 | 1.0 | 7.0 | .43 | | .18 | .27 | .36 | .39 | .22 | .20 | .23 | .30 | .33 | .24 | | | | | .29 | .28 |
| 1008 | 3.0 | | .34 | | .37 | | .31 | | .28 | | .33 | | .40 | | | | | | .34 | |
| 1016 | 1.0 | 9.0 | .35 | | .17 | .15 | .32 | .30 | .37 | .21 | .26 | .29 | | | | | | | .29 | .24 |
| Mean | | | .37 | | .18 | .20 | .35 | .36 | .25 | .28 | .26 | .28 | .33 | .26 | | | | | | |

TABLE 12

TOTAL PHOSPHORUS

AS P ppm

| 1 9 6 9 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | .04 | | .01 | .02 | .02 | .03 | .01 | .01 | | .02 | .02 | .02 | .03 | .02 | | | .02 | .02 |
| 501 | 1.0 | 9.0 | .02 | | .01 | .01 | .02 | .02 | .01 | .01 | .01 | .03 | .02 | .02 | .02 | .02 | | | .02 | .02 |
| 518 | 3.0 | | .03 | | .02 | | .03 | | .01 | | .01 | | | | .03 | | | | .02 | |
| 648 | 1.0 | 7.0 | .02 | | .01 | .01 | .02 | .02 | | | .01 | .01 | | | .02 | .02 | | | .02 | .02 |
| 810 | 1.0 | 8.0 | .03 | | .01 | .02 | .02 | .02 | .01 | .01 | .01 | .01 | | | .03 | .03 | | | .02 | .02 |
| 994 | 1.0 | 7.0 | .05 | | .01 | .02 | .03 | .04 | .02 | .02 | .01 | .01 | .02 | .02 | .02 | .02 | | | .03 | .02 |
| 1008 | 3.0 | | .02 | | .02 | | .02 | | .02 | | .03 | | .02 | | .03 | | | | .02 | |
| 1016 | 1.0 | 9.0 | .02 | | .02 | .03 | .02 | .02 | .01 | .01 | .01 | .01 | | | .02 | .02 | | | .02 | .02 |
| Mean | | | .03 | | .01 | .02 | .02 | .03 | .01 | .01 | .01 | .02 | .02 | .02 | .03 | .02 | | | | |

TABLE 13

PHENOLS

ppb

| 1969 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Depth (ft) | | 22 Apr | | 16 June | | 14 July | | 12 Aug | | 8 Sept | | 6 Oct | | 3 Nov | | 4 Dec | | Mean | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| 112 | 1.0 | 12.0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | | | 0 | 2 |
| 501 | 1.0 | 9.0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 |
| 518 | 3.0 | | 0 | | 0 | | 0 | | 0 | | 0 | 0 | | | 0 | | | | 0 | 0 |
| 648 | 1.0 | 7.0 | 0 | | 0 | 0 | 0 | 0 | | | 0 | 0 | | | 0 | 0 | | | 0 | 0 |
| 810 | 1.0 | 8.0 | 0 | | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | | | 0 | 0 |
| 994 | 1.0 | 7.0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 |
| 1008 | 3.0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | | | 0 | |
| 1016 | 1.0 | 9.0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | | | 0 | 0 |
| Mean | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | | | | |